SUPPORT FOR THE AMENDMENTS

This Amendment amends the title; amends the specification; amends Claim 1; adds new Claim 14; amends Fig. 4; and replaces the Abstract. Support for the amendments is found in the specification and claims as originally filed. In particular, support for the paragraph beginning at page 24, line 15, is found in the specification at least at Table 6. Support for the paragraph beginning at page 25, line 6, is found in the specification at least at Table 6. Support for Table 7 is found in the specification at least at Examples 24-29. Support for Claim 1 is found in the specification at least at page 4, line 18 to page 5, line 2. The abstract is rewritten as a single paragraph. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 1-14 will be pending in this application. Claim 1 is independent.

REMARKS

Applicants respectfully request entry of the foregoing, and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

The title of the invention is objected to as not being descriptive. To obviate this objection, the title is replaced with a new title. Thus, the objection to the title should be withdrawn. Applicants respectfully request reconsideration and withdrawal of the objection.

The disclosure is objected to because of various informalities. To obviate this objection, the specification at page 10, line 2, and page 16, line 22, is amended. Therefore, the objection to the disclosure should be withdrawn. Applicants respectfully request reconsideration and withdrawal of the objection.

Claims 1-7 and 9-10 are rejected under 35 U.S.C. §102(e) over U.S. Patent No.

6,096,456 ("Takeuchi"). In addition, Claims 1-7 and 9-13 are rejected under 35 U.S.C. §103(a) over U.S. Patent No. 6,124,061 ("Hamano") in view of Takeuchi. Applicants respectfully traverse these rejections because the cited prior art fails to disclose, teach or suggest all the limitations of the claimed invention; in particular, the independent Claim 1 limitation of "an adhesive resin layer ... *joined directly* to *both* of the positive and the negative electrodes".

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. MPEP §2131. To establish a prima facie case of obviousness, the prior art reference (or references where combined) must teach or suggest all the claim limitations. MPEP §2143.

The present invention provides a light, compact and thin battery in which a positive and a negative electrode are joined firmly to maintain the adhesive strength while securing both electron insulation and ion conduction between electrodes and decreasing resistance between electrodes, i.e., internal resistance of a battery, to improve battery characteristics. Specification at page 4, lines 8-15. The battery according to the invention comprises an adhesive resin layer which is interposed in between the positive and negative electrode. Specification at page 4, lines 17-21. The positive electrode and the negative electrodes are directly bonded to the adhesive resin layer. Specification at page 5, lines 1-2.

In contrast to the claimed invention, Takeuchi and Hamano both disclose batteries comprising the following five layer structure: positive electrode/ adhesive/ separator/ adhesive/ negative electrode. See, e.g., Takeuchi at column 25, lines 20-22; Hamano at abstract and Fig. 1.

However, the cited prior art fails to disclose, teach or suggest the three layer structure of the present invention shown as follows: positive electrode/ adhesive/ negative electrode.

As a result, the cited prior art fails to disclose, teach or suggest the independent Claim 1 limitation of "an adhesive resin layer ... *joined directly* to *both* of the positive and the negative electrodes". Therefore, the various rejections under 35 U.S.C. §102(e) and §103(a) should be withdrawn. Applicants respectfully request reconsideration and withdrawal of the rejections.

Pursuant to M.P.E.P. §821.04, Applicants respectfully request examination of new method Claim 14, which includes all of the limitations of product Claim 1.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

MARKED-UP COPY OF AMENDMENTS

IN RE APPLICATION OF: :

SHIGERU AIHARA ET AL : EXAMINER: DOVE, T.

SERIAL NO: 09/381,295 :

FILED: SEPTEMBER 22, 1999 : GROUP ART UNIT: 1745

FOR: BATTERY

Marked-Up Copy
Serial No: 09/381,295
Amendment Filed on:
March 14, 2001

AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

In response to the Office Action mailed December 15, 2000, please amend the application identified above as follows (marked-up copy of amendments attached):

IN THE TITLE

Please replace the title with --BATTERY WITH ADHESION RESIN LAYER INCLUDING FILLER--.

IN THE SPECIFICATION

Please amend the specification as follows:

Paragraph beginning at page 9, line 18:

(Amended) If an adhesive resin solution containing no filler is applied to an electrode (a positive and a negative electrode) for bonding, the adhesive resin solution will be absorbed by the electrode that is porous. Where a filler is mixed into the adhesive resin solution, the

adhesive resin layer is provided with a porous structure formed by the filler. Since the adhesive resin solution is held in the pores of the porous structure and thereby prevented from being absorbed by the electrode, the adhesive resin solution can be maintained on the [adherend] adhered surface. Further, this effect brings about an increase in viscosity of the adhesive resin solution to further improve adhesive resin holding properties.

Paragraph beginning at page 10, line 5:

(Amended) The average particle size of the filler to be added is preferably not greater than that of the electrode active material, particularly 1 μm or smaller. Filler particles having an average particle size of [1 μm or greater] greater than 1 μm form pores the diameter of which approximates the pore size of the electrode, and the ability of holding the electrolytic solution decreases. Where filler particles have an average particle size equal to or greater than the particle size of the electrode active material, the pores lose the ability of holding the electrolyte, resulting in reductions of battery characteristics. That is, the filler added produces no substantial effect. The sedimentation velocity of the filler particles in the adhesive resin solution increases with an increasing average particle size, which considerably deteriorates the handling properties of the adhesive resin solution. With the average particle size being 1 μm or smaller, the filler moderately increases the viscosity of the adhesive resin solution and makes the adhesive resin layer porous. The adhesive resin solution and the electrolytic solution can thus be held in the interface between electrodes.

Paragraph beginning at page 16, line 6:

(Amended) A positive electrode active material layer consisting of 91 parts by weight of $LiCoO_2$ having an average particle size of 10 μm (produced by Nippon Chemical Industrial Co.,

Ltd.), 6 parts by weight of graphite powder (produced by LONZA Ltd.), and 3 parts by weight of polyvinylidene fluoride (produced by Kureha Chemical Industry Co., Ltd.) was applied to an aluminum foil substrate to an average coating thickness of 80 μm to form a positive electrode. A negative electrode active material layer consisting of 90 parts by weight of mesophase microbeads (produced by Osaka Gas Co., Ltd.) having an average particle size of 8 μm and 10 parts by weight of polyvinylidene fluoride was applied to a copper substrate to an average coating thickness of 80 μm to form a negative electrode. An adhesive resin solution for joining these electrodes was prepared by dispersing and dissolving polyvinylidene fluoride (produced by Elf Atochem Japan) and alumina powder having an average particle size of 0.01 μm (produced by Degussa Corporation) in a concentration of 10 wt% each in [N-methlpyrrolidone] N-methylpyrrolidone. The positive electrode and the negative electrode were cut in sizes of 50 mm x 50 mm and 55 mm x 55 mm, respectively. A cut piece of the negative electrode was coated with the adhesive resin solution on a screen printing machine using a 200 mesh screen and bonded to a cut piece of the positive electrode. The laminate was dried in a drier at 80°C for 1 hour to prepare a unit electrode body. The thickness of the formed adhesive resin layer was controllable by choice of the mesh size. In this example, the thickness was 20 μm.

Paragraph beginning at page 24, line 15:

(Amended) Electrodes were prepared, a battery was assembled, and evaluation was made in the same manner as in Example 1, except for using an adhesive resin solution prepared by dissolving and dispersing 10 wt% of polyvinylidene fluoride, 9 wt% of alumina powder having an average particle size of 0.01 μm, and [9] 1 wt% of silica powder having an average particle size of 0.5 μm in N-methylpyrrolidone.

Paragraph beginning at page 25, line 6:

(Amended) Electrodes were prepared, a battery was assembled, and evaluation was made in the same manner as in Example 1, except for using an adhesive resin solution prepared by dissolving and dispersing 10 wt% of polyvinylidene fluoride, 9 wt% of alumina powder having an average particle size of 0.01 μm, and 1 wt% of [alumina powder] silicon carbide having an average particle size of 0.5 μm in N-methylpyrrolidone.

Paragraph beginning at page 31, line 23:

(Amended) A positive electrode, a negative electrode, and an adhesive resin solution were prepared in the same manner as in Example 1. A band of 300 mm x 50 mm and of 305 mm x 55 mm was cut out of the positive electrode and the negative electrode, respectively. The adhesive resin solution was applied to a side of the [separator] positive electrode on a screen printing machine. One end of the coated positive electrode was folded back at a prescribed length. The negative electrode band was inserted into the center of the fold. Subsequently, the folded positive electrode and the negative electrode were superposed and passed through the laminator. The adhesive resin solution was applied to the other side of the positive electrode that was opposite to the side previously coated with the adhesive resin solution, and the laminate was rolled up into an oblong cylinder.

Paragraph beginning at page 36, line 13 from the bottom:

(Amended) Table 3 shows the results obtained when the ratio of the alumina filler to the adhesive resin was varied. These results are graphed in Fig. 6, in which the peel strength and the battery capacity are plotted against volume percentage of the voids. The proportion of the adhesive resin in the void volume formed by the filler changes with a change of the filler to resin

ratio, and a change of the void volume in the adhesive resin layer follows. If the volume percentage of the voids is [20% or] less than 20%, passages for ions through the adhesive resin layer are diminished, resulting in an obvious reduction in discharge capacity. On the other hand, the adhesive strength tends to reduce with an increase of volume percentage of the voids. If the volume percentage of the voids is [80% or] more than 80%, the amount of the filler is so large that the amount of the adhesive resin is insufficient, resulting in an extreme reduction in adhesive strength.

TABLE 1 (Amended)

	Adhesive				Peel strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle Size of Filler (μm)		
Example 1	PVDF	alumina	1:1	0.01	50	60
Compara. Example 1	PVDF	none	-	-	100	20
Example 2	PVA	alumina	2:5	0.01	70	60
Compara. Example 2	PVA	none	-	-	100	30

TABLE 2 (Amended)

	Adhesive				Peel strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle Size of Filler (μm)		
Example 1	PVDF	alumina	1:1	0.01	50	60
Example 3	PVDF	alumina	1:1	0.1	60	55
Example 4	PVDF	alumina	1:1	1	65	50
Example 5	PVDF	silica	1:1	0.007	45	60
Compara. Example 3	PVDF	alumina	1:1	10	60	25

TABLE 3 (Amended)

	Adhesive				Volume of Solid Matter (%)	Void Volume (%)	Peel Strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle size of Filler (μm)				
Example 1	PVDF	alumina	1:1	0.01	50	50	70	62
Example 6	PVDF	alumina	2:1	0.01	70	30	85	58
Example 7	PVDF	alumina	1:5	0.01	30	70	60	65
Compara. Example 4	PVDF	alumina	10:1	0.01	90	10	100	20
Compara. Example 5	PVDF	alumina	1:10	0.01	10	90	20	65

TABLE 4 (Amended)

	Adhesive				Thickness (μm)	Peel Strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle size of Filler (μm)			
Example 1	PVDF	alumina	1:1	0.01	20	70	60
Example 8	PVDF	alumina	1:1	0.01	50	70	58
Example 9	PVDF	alumina	1:1	0.01	100	70	55
Example 10	PVDF	alumina	1:1	0.01	150	70	50
Example 11	PVDF	alumina	1:1	0.01	10	60	60
Example 12	PVDF	alumina	1:1	0.01	200	70	30

TABLE 5 (Amended)

	Adhesive				Peel Strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle Size of Filler (μm)		
Example 1	PVDF	alumina	1:1	0.01	50	60
Example 13	PVDF	silica	1:1	0.01	50	60
Example 14	PVDF	silicon carbide	1:3	0.5	80	50
Example 15	PVDF	boron carbide	1:3	0.5	80	50
Example 16	PVDF	silicon nitride	1:3	0.5	80	50
Example 17	PVDF	PMMA	2:1	0.5	80	50

TABLE 6 (Amended)

	Adhesive								Peel Strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Resin		Filler 1			Filler 2				
	Kind	Weight Ratio	Kind	Weight Ratio	[Average] Particle Size of Filler (μm)	Kind	Weight Ratio	[Average] Particle Size of Filler (μm)		
Example 1	PVDF	1	alumina	1	0.01	none	0	0	50	60
Example 18	PVDF	1	alumina	0.9	0.01	alumina	0.1	1	55	55
Example 19	PVDF	1	alumina	0.5	0.01	silica	0.5	0.01	50	60
Example 20	PVDF	1	alumina	0.9	0.01	silica	0.1	0.5	55	55
Example 21	PVDF	1	alumina	0.9	0.01	PMMA	0.1	0.5	55	55
Example 22	PVDF	1	alumina	0.9	0.01	silicon carbide	0.1	0.5	55	55
Example 23	PVDF	1	silicon carbide	0.5	0.5	PMMA	0.5	0.5	80	55

Table 7 (Amended)

	Adhesive										Peel Strength (gf/cm)	Discharge Capacity (1C) (mAh)
	Adhesive Resin Layer (Intermediate Layer)					Adhesive Resin Layer (Electrode Surface Layer)						
	Adhesive Resin		Filler			Adhesive Resin		Filler				
	Kind	Weight Ratio	Kind	Weight Ratio	[Average] Particle Size of Filler (μm)	Kind	Weight Ratio	Kind	Weight Ratio	[Average] Particle Size of Filler (μm)		
Example 1	PVDF	1	alumina	1	0.01	none	-	-	-	-	50	60
Example 24	PVDF	1	alumina	1	0.01	PVDF	1	iron	[1] 2	0.5	55	50
Example 25	PVDF	1	alumina	1	0.01	PVDF	1	carbon	[1] 5	1	55	50
Example 26	PVDF	1	silicon carbide	[1] 3	0.5	PVDF	1	iron	[1] 2	[0.5] 1	80	45
Example 27	PVDF	1	silicon carbide	[1] 3	0.5	PVDF	1	carbon	[1] 5	1	80	45
Example 28	PVDF	1	PMMA	[1] 0.5	0.5	PVDF	1	iron	[1] 2	[0.5] 1	80	45
Example 29	PVDF	1	PMMA	[1] 0.5	0.5	PVDF	1	carbon	[1] 5	1	80	45

Table 8 (Amended)

	Adhesive				Battery Structure	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle Size of Filler (μm)		
Example 1	PVDF	alumina	1:1	0.01	tabular unit electrode body	60
Example 30	PVDF	alumina	1:1	0.01	tabular laminated electrode body	360
Example 31	PVDF	alumina	1:1	0.01	"	360
Example 32	PVDF	alumina	1:1	0.01	tabular rolled electrode body	360
Example 33	PVDF	alumina	1:1	0.01	"	360

Table 9 (Amended)

	Adhesive				Battery Structure	Discharge Capacity (1C) (mAh)
	Resin	Filler	Weight Ratio	Particle Size of Filler (μm)		
Example 1	PVDF	alumina	1:1	0.01	screen printing	60
Example 34	PVDF	alumina	1:1	0.01	roll coater	60
Example 35	PVDF	alumina	1:1	0.01	gravure printing	60
Example 36	PVDF	alumina	1:1	0.01	doctor blade	60
Example 37	PVDF	alumina	1:1	0.01	bar coater	60

IN THE CLAIMS

Please amend Claim 1 as follows:

1. (Amended) A battery comprising a battery body including:

a positive and a negative electrode containing an active material,

an electrolytic solution containing an electrolyte, and

an adhesive resin layer which is interposed in between the positive electrode and the negative electrode and is joined directly to [at least one] both of the positive and the negative electrodes, wherein

the adhesive resin layer comprises at least one layer and contains fillers.

Please add new Claim 14 as follows:

--14. (New) A method of making a battery, the method comprising

assembling a positive electrode, a negative electrode; an electrolytic solution and an adhesive resin layer in a battery body; and

forming the battery of Claim 1.--

IN THE DRAWINGS

Please amend Fig. 4 as indicated in the attached Letter Requesting Approval Of Drawing Corrections.

IN THE ABSTRACT

Please replace the abstract with the attached abstract.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Corwin Paul Umbach

Norman F. Oblon
Attorney of Record
Registration No. 24,618

Corwin P. Umbach, Ph.D.
Registration No. 40,211

Attachment:
Marked-up copy of amendments
Abstract
Letter Requesting Approval Of Drawing Changes

22850
Tel. (703) 413-3000
Fax. (703) 413-2220
NFO:CPU

I:\atty\Cpu\00572521.rev2dAM.wpd